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(72) Inventors FRANZ KLEINER
KARL HEINZ MÜLLER

(19) THE PATENT OFFICE LONDON

(54) APPARATUS FOR THE CONTINUOUS PRODUCTION OF CONTINUOUS PLASTICS FOAM WEBS

above melting point of PE

(71) We BAYER AKTIENGESELLSCHAFT, a body corporate organised under the laws of Germany of 5509 Leverkusen, Germany do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

The invention relates to an apparatus for the continuous production of continuous plastics foam sheets by the cross-linking and expansion of extruded polyolefin sheets containing peroxide and at least one heat-decomposable blowing agent.

Plastics foams of low density of cross-linked poly olefins, in particular high pressure polyethylene, possess a series of properties which permits their use in greatly varying applications. Economic production is the requirement which must be met to exploit these advantages.

Several processes for the production of these plastics foam sheets are already known.

In a discontinuous process far example a mixture of a high pressure polyethylene is homogenised with a blowing agent and a cross-linking agent on a mixer.

The non-cross-linking and unexpanded rolling sheet is laid in a gas-tight, fitting mould. Heating to above the separation temperature of the blowing agent and cooling to below the point of solidification takes place under high pressure. The actual expansion then takes place in a heating chamber at temperatures of from 85 to 110°C. This process produces a plastics foam of high quality which is however limited in its dimensions by the size of the press available and which, because of the technical complexity, is very expensive.

A continuous sheet is produced from polyethylene containing blowing agents, in a continuous process, using an extruder, which is partially cross-linked by heat radiators with suitable intensity and wavelengths at a temperature just above the crystallite melting point. The sheet thus pre-treated is expanded at a temperature above the decomposition temperature of the blowing agent, either on one side running over heated rollers, or on both sides with simultaneous downwards movement and lateral guiding by revolving induced draught belts by means of heat radiators to form a plastics foam sheet.

In addition to high capital investment required, the low thickness of the plastics foam sheets which can be achieved of 5 to 6mm is disadvantageous. Moreover the formation of folds in the plastics foam sheet cannot always be avoided in the case of lateral guiding.

In a further continuous process, in addition to the blowing agent, a cross-linking agent, e.g. peroxide, is added to the polyethylene and this mixture is also extruded without reaction of the additive to form a continuous sheet which is then preheated in a continuous furnace on a conveyor belt of wire material from both sides by a hot air flow increasing in three heating stages, then cross-linked and expanded to form plastics foam sheets.

This process requires a long broad furnace since the process stages are juxtaposed and the conveyor belt running through the furnace must be designed over the whole length for the greatest width, namely the width of the finished plastics foam sheet. The unintentional adhesion of the surface layer of the sheet melted for cross-linking purposes to the wire material and the friction on the belt during foaming increases the danger of fold formation.

The object of the invention is to an apparatus which facilitate the continuous production of continuous plastics foam sheets from polyolefin using cross-linking and blowing agents with low energy consump-

1,2,3,4,5,6
9,10,1,12

tion and compact construction and providing expansion unhindered on all sides without fold formation.

According to the invention, there is provided an apparatus for the continuous production of continuous plastics foam sheets comprising a perforated conveyor belt for conveying a polyolefin sheet, heating devices arranged above and below the surface of the conveyor belt on which the sheet is conveyed in a plurality of consecutive heating zones and means for directing hot air towards the web after it is released from the conveyor belt, so as to guide the sheet while it is suspended freely in space and so as to apply heat to the sheet to induce foaming.

The means for directing hot air may comprise a revolving wheel sub-divided into cells from which the air is directed outwardly towards the sheet, the hot air being supplied to the cells from a zone at least partially surrounded by flaps which do not revolve about the axis of the wheel and which, when open, allow hot air to enter the cells.

As a result of the adjustability of the flaps, the form of the cellular wheel periphery and the arrangement of the hot air openings, the polyolefin foam sheet is conveyed in a stable fashion suspended freely in space, so that optimum conditions are present for foaming.

In one embodiment of the apparatus according to the invention, the heating devices are arranged in three consecutive heating zones.

Two or more mutually opposed blowers with feed pipes for hot air may be arranged after the release point of the sheet. By virtue of this embodiment the sheet can also be substantially stabilised in order to avoid fold formation and at the same time be subjected on all sides to hot air for total expansion.

In a particular embodiment of the apparatus according to the invention, in order to adjust a pre-stressing and gripping power of the polyolefin sheet, the conveyor belt is adjustable at an angle between 0 and 50° to the horizontal.

By a corresponding adjustment of the angle of the conveyor belt, the longitudinal pre-stressing for influencing the transverse contraction during the cross-linking of the polyolefin strip and the cohesion of the free-hanging loop can be favourably influenced. At the same time the raising of the extruder necessary to accommodate the foaming sheet is avoided.

The apparatus according to the invention may be used to carry out a process for the continuous production of continuous plastics foam sheets by the cross-linking and expansion of extruded polyolefin sheets containing peroxide and at least one heat-decomposable blowing agent, wherein the polyolefin sheet is carried on a perforated conveyor belt on which it is first preheated to a temperature below the melting point, then heated to a temperature from 50° to 100°C higher than the preheating temperature to cause cross-linking, whereafter the sheet is released from the conveyor belt by gravity and, while suspended freely in space and guided aerodynamically, is foamed under renewed heat application to cause decomposition of the blowing agent or agents.

The advantages achieved with this process are that, quite unexpectedly and surprisingly in relation to the previous teaching, after heating for a short time to a temperature of 50 to 100°C above the melting point of the polyethylene, the cross-linking process continues by exothermic heat development, while the blowing agent decomposition may be terminated optionally by blowing with cooler air.

By separating the cross-linking and foaming process, it is possible to substantially shorten the conveyor belt which here is only required during cross-linking and to limit it to the smaller width of the extruded sheet. At the same time the hot air circulation is more favourable because of the smaller space.

The quantity of heat required for cross-linking is lower since after the above mentioned heating for a short time, the further cross-linking process takes place automatically by exothermic heat development. The structure of the plastics foam sheet is more uniform as a result of the possibility of free expansion on all sides. The surface is also favourably influenced by the gentle release of the polyolefin sheet from the belt by means of gravity. The formation of folds no longer occurs because of the stabilisation of the polyolefin sheet by the hot air flow.

Embodiments of the invention are illustrated in the accompanying drawings and described in more detail in the following.

Figure 1 shows a first embodiment of an apparatus according to the invention comprising a cellular wheel shown in section.

Figure 2 shows a cellular wheel in section.

Figure 3 shows a second embodiment of an apparatus according to the invention comprising a blower shown in section.

As shown in Figure 1, a perforated conveyor belt rising at an angle in the range of from 0 to 50° which is loaded with an extruded polyolefin sheet 2 containing wetting and blowing agents, after passing an insulated housing outer wall 3 runs between the heaters 4 to 10 arranged in each case on either side of the sheet for heating the

sheet. Heaters 4 and 5 bring the sheet to a temperature just below the melting point, heaters 6 and 7 trigger off the cross-linking at a temperature higher by from 50° to 100°C, and heaters 8, 9 and 10 maintain the sheet at the cross-linking temperature. Infrared radiators, electrical resistance elements or hot air heaters can be used as the heaters. Below the release point 11 of the polyolefin sheet from the conveyor belt 1 there is arranged a cellular wheel 12, which by means of hot air fed in through an axial inflow pipe 13, adjustable flaps 14 and radial outlet openings 19 guides the freely hanging polyolefin sheet with simultaneous foaming, and this process is further assisted by further hot air from chambers 15, 16, 17.

Figure 2 shows in detail the cross-section of the cellular wheel 12. Hot air issues from the nozzles 19 which both guide the polyolefin sheet as a result of aerodynamic forming without creases and freely suspended in space, and supplies the necessary heat for the complete foaming of the sheet, with further hot air being supplied through openings in the chamber 17 to assist the process.

In Figure 3, the conveyor belt 20 is equipped with individually adjustable infrared radiators 21. Below the release point 22 there are arranged two mutually opposed blowers 23, 24, which are fed with hot air from the connections 25, 26, to supply heat for the purpose of foaming and stabilising the loop. Water cooled discharge rollers 27 are provided at the furnace floor to support the finished plastics foam sheet.

EXAMPLE

Using the apparatus of Figures 1 and 2, an extruded, continuous sheet of high pressure polyethylene provided with peroxide and blowing agent having a thickness of 3.2mm and a width of 400mm is conveyed on a conveyor belt rising at 45° consisting of wire fabric at a speed of 2.3 m/min. into a furnace and subjected on both sides to hot air from chambers.

Hot air 140°C is used for pre-heating. The subsequent cross-linking is triggered off by a hot air surge at 238°C and then takes place spontaneously at a hot air temperature of 160°C.

After release from the conveyor belt, the sheet, stabilised by the hot air flow from the cellular wheel and chambers connected thereto, is foamed by the decomposition of the blowing agent at a hot air temperature of 222°C to form a finished plastics foam sheet having a thickness of 11mm and a width of 1.1m, and after leaving the furnace is wound.

WHAT WE CLAIM IS: —

1. An apparatus for the continuous production of continuous plastics foam sheets comprising a perforated conveyor belt for conveying a polyolefin sheet, heating devices arranged above and below the surface of the conveyor belt on which the sheet is conveyed in plurality of consecutive heating zones and means for directing hot air towards the web after it is released from the conveyor belt, so as to guide the sheet while it is suspended freely in space and so as to apply heat to the sheet to induce foaming.

2. An apparatus as claimed in claim 1, wherein the means for directing hot air towards the sheet comprises a revolving wheel subdivided into cells from which the air is directed outwardly towards the sheet, the hot air being supplied to the cells from a zone at least partially surrounded by flaps which do not revolve about the axis of the wheel and which when open, allow hot air to enter the cells.

3. An apparatus as claimed in claim 2, further comprising a chamber radially spaced from the wheel and extending around a portion of the periphery thereof from which hot air may be directed inwardly towards the sheet.

4. An apparatus as claimed in Claim 1, wherein the means for directing hot air towards the sheet comprises at least two inlet pipes for hot air and at least two blowers for directing the hot air towards the sheet.

5. An apparatus as claimed in Claim 4, further comprising water cooled rollers for removing the sheet from the zone in which it is suspended freely in space.

6. An apparatus as claimed in any one of Claims 1 to 5, wherein the conveyor belt is adjustable at an angle from 0° to 50° to the horizontal.

7. An apparatus as claimed in any one of Claims 1 to 6, wherein the heating devices are hot air heaters.

8. An apparatusas claimed in any of Claims 1 to 6, wherein the heating devices are infrared radiators.

9. An apparatus as claimed in any one of Claims 1 to 6, wherein the heating devices are electrical resistance heaters.

10. An apparatus substantially as herein described with reference to Figures 1 and 2 or Figure 3 of the accompanying drawings.

ELKINGTON AND FIFE,
Chartered Patent Agents,
High Holborn House,
52/54 High Holborn,
London WC1V 6SH.
Agents for the Applicants

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1562814 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

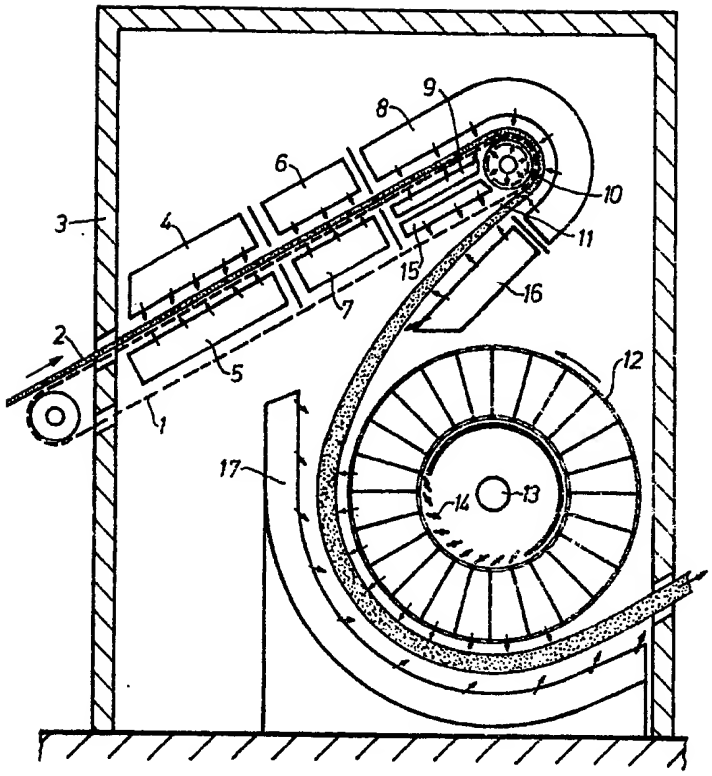


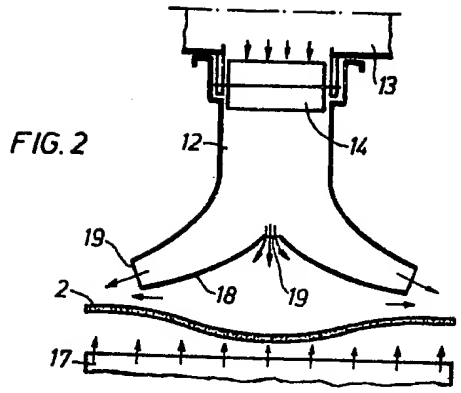
FIG. 1

1562814 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

FIG. 2



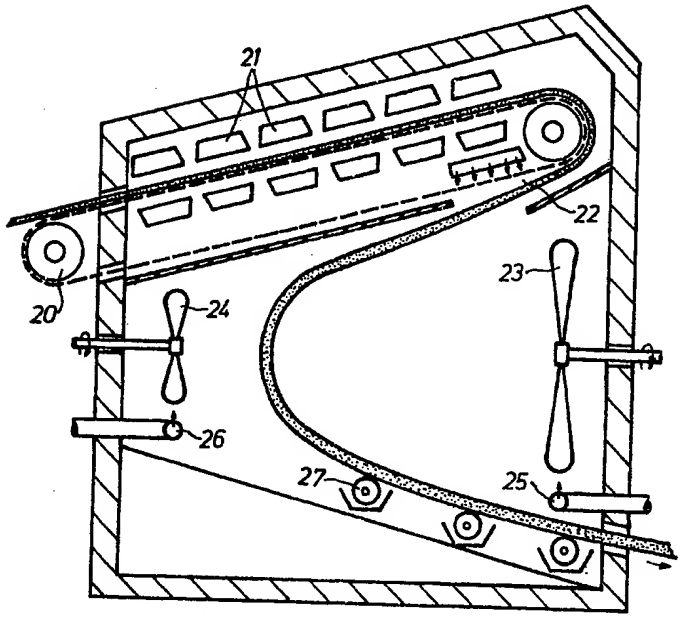


FIG. 3